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Population and habitat viability assessment of tiger population in the north-western Terai-Arc Landscape

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1. **Title of the project:** **Population and habitat viability [illegible]**
of tiger subpopulations in the [illegible]
Terai-Arc Landscape

2. **Name of the investigator:** Dr. S. P. Goyal

Researcher: Abishek Harihar

3. **Duration of the project:** One year

4. **Date of initiation of project:** January 2009

Date of completion of project: December 2009

5. **Study area:** Rajaji National Park, Hardwar Forest Division, Dehra Dun Forest Division and Shivalik Forest Division, Uttarakhand, India.

Introduction

Vast tracts of forested landscape that was once inhabited by tigers *Panthera tigris* have now been lost to human habitation, causing a sharp decline in ungulate populations and confining many of the remaining populations to small, isolated patches of forests (Smith et al., 1998). With the illegal killing of tigers for body parts accelerating the rate of local extinctions (Project Tiger, 2005), long-term conservation of tigers requires the identification, protection and management of habitats to secure breeding populations as source pools and provide dispersal opportunities by linking habitat patches across the landscape (Johnsingh et al., 2004; Wikramanayake et al., 2004; Jhala et al., 2008) to maintain genetic fitness.

The Terai-Arc Landscape, encompassing the Shivalik hills and the Terai flood plains, is one of the five landscapes identified for tiger conservation in India (Jhala et al. 2008). With a human population density of > 500 people km^{-2} (the national average is 300 people km^{-2}; Johnsingh et al., 2004), populations of tigers occur in forest patches comprising a matrix of protected areas, multiple use forests (Forest Divisions), agricultural land and human habitation. The north-western portion of this landscape (proposed study area) spans from the Lansdowne Forest Division in the east to the Yamuna River in the west, forming the distributional limit of tigers in the Indian subcontinent. Encompassing the protected areas of Corbett Tiger Reserve and Rajaji National Park which cover only c. 30% of the area, it is fragmented into two disjunct units identified as Tiger Habitat Blocks, with poor or no connectivity because of anthropogenic disturbances (Johnsingh et al., 2004). Covering nearly 6,600 km^2, this hilly (*bhabar*) tract could potentially support a minimum of 150 adult tigers if corridors were established and adequate protection provided (Johnsingh, 2006). From east to west these Tiger Habitat Blocks include multiple use forests, Corbett Tiger Reserve and the eastern part of Rajaji National Park covering c. 3,000 km^2 from the west bank of Gola River to the east bank of Ganga River (Block II), and the western part of Rajaji National Park and multiple use forests covering c. 1,800 km^2 from the west bank of Ganga River to Yamuna River (Block I), forming the north-western population limit of tigers in the Indian subcontinent (Fig. 1).

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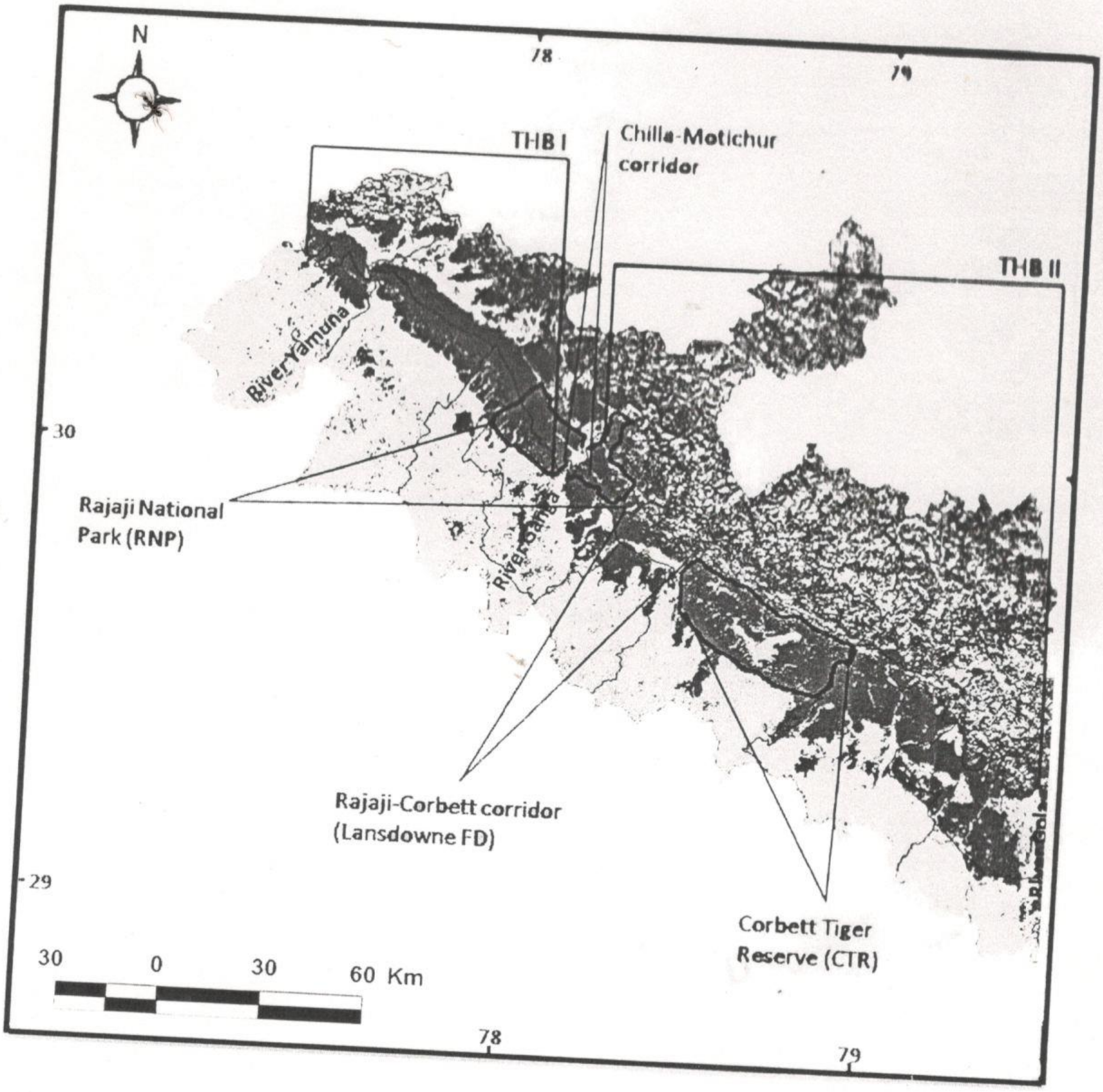

Figure 1. North-western limit of the Terai-Arc Landscape showing major rivers (Yamuna, Ganga & Gola), Tiger Habitat Blocks (THB I & II), corridors (Chilla-Motichur & Rajaji-Corbett) and the protected areas of Rajaji National Park (RNP) and Corbett Tiger Reserve (CTR).

Earlier studies (Johnsingh et al. 2004) documented a high tiger use within Corbett Tiger Reserve (c. 41%) and adjoining forest divisions (Ramnagar Forest Division;c. 20.7%) based on frequency of indirect tiger signs recorded from 82 km of sign survey. In addition, Contractor (2007) estimated a high density of > 16 tigers per 100 km^2 in Corbett National Park (c. 520 km^2; part of Corbett Tiger Reserve). This highlights the role of this Reserve as a critical source population. Conversely, Johnsingh et al. (2004) documented a relatively lower tiger use within Rajaji National Park (c. 12.9%), most of which was attributed to signs

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recorded in Dholkhand in the western sector and the eastern sector. However, following the minimization of anthropogenic pressures from within the Chilla Range of east Rajaji National Park in 2004, Harihar et al. (2008) documented evidence of breeding tigers, suggesting the potential of the east sector as a source population. Yet sign encounter rates of tigers between the western and eastern sectors of Rajaji National Park differed significantly indicating that the status of tigers in the western sector was precarious even though most forest ranges have been free of *Gujjar* settlements since 2005 (Harihar et al. in press). As the eastern sector is contiguous with Corbett Tiger Reserve, the documented recovery in Chilla range (Harihar et al., 2008) could be attributed to the colonization by dispersing individuals from Corbett Tiger Reserve facilitated by the Rajaji-Corbett corridor (Lansdowne Forest Division). However, western Rajaji National Park and adjoining multiple use forests (Tiger Habitat Block I) depend on the Chilla-Motichur corridor for connectivity to source populations in Tiger Habitat Block II) (Johnsingh et al., 1990; Johnsingh et al. 2004).

The Chilla-Motichur corridor (c. 3 km^2) connecting eastern and western Rajaji National Park across the river Ganga is highly disturbed by developmental activities along the river. The expansion of Haridwar and Rishikesh townships and Raiwala village are causing disturbances along the west bank of the river Ganga. The establishment of Khand *gaon* settlements (I, II and III) for the Tehri dam evacuees, Raiwala Army camp with an ammunition dump, and the Hindustan Antibiotic Factory on the west bank of river Ganga, and the construction of the 14 km long Rishikesh-Chilla power channel on the east bank of river Ganga have further severed habitat connectivity. Apart from the lack of connectivity to source populations, western Rajaji National Park is also disturbed because of the proximity of human habitation to the Park boundary. While firewood collection and lopping of trees cause habitat degradation, the illegal grazing of livestock within the Park poses the threat of retaliatory poisoning of tiger kills by livestock owners. In addition, grass cutters harvesting *bhabar* grass *Eulaliopsis binata* access the interior hilly tracts of the park disturbing habitats and stealing fresh tiger kills. Such activities render the area unsuitable for successful breeding of tigers. As populations at their range limits are more susceptible to local extinctions, ensuring the long-term persistence of tigers within this landscape requires quantitative information on existing populations, and opportunities for dispersal and connectivity between populations.

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Project Objectives

Based on the results presented in Harihar et. (2008), it is evident that tigers in east Rajaji National Park have in the recent past been increasing in numbers, thereby making it important to identify forest patches where the colonization of dispersing individuals can be facilitated in the long run. As documented by (Harihar et al. In press), west Rajaji National Park with its currently low tiger density and high density of prey can serve as ideal dispersal grounds provided the recommendations of Johnsingh et al. (1990) and Johnsingh et al. (2004) are implemented without further delay. Therefore in this study, we propose to carry out sampling across the landscape (east Rajaji National Park to Yamuna River) with the following objectives:

1. To map probability of prey species within Geographic Information System (GIS) using occupancy models from pellet encounter data based on a hierarchical sampling design.

2. To construct spatially explicit tiger habitat model based on detection-nondetection data using landscape attributes and prey availability as explanatory variables.

3. To estimate the subpopulation size of tigers using photographic capture-recapture sampling within the identified tiger use areas.

4. To model the viability of the subpopulations within the landscape under various management strategies.

Methods

Estimating the occupancy rates of principal prey species

In order to estimate the occupancy of wild ungulate prey species in the landscape, the entire study area would first be gridded into 2km x 2km grids. Following this, grids will be chosen systematically to carry out sampling. Within each of the selected grids a transect of

2km would be laid and nested sampling plots at an intervals of 200m would be used to sample for vegetation and animal signs. At each of the sampling points, GPS location is taken and a 10m radius circular plot would be used assess the tree species composition, tree density and canopy cover, a nested 5m radius circular plot would be used to assess the shrub species composition, percent shrub cover, average shrub height and pellet group count while five 1m radius plots would be sampled within the larger 10m radius plot for grass and herb species composition, average vegetation height and percent cover of grass and herbs, bare ground and rock. In addition, variables such as density of domestic livestock dung, cutting and lopping signs, and human trails would be quantified as indices of disturbance. In order to model for wild ungulate occupancy, repeat counts of ungulate pellet counts would be used under the occupancy models in program PRESENCE2.0 (Hines 2006) wherein percent shrub cover and percent cover of grass and herbs would be used to model detection probabilities (*p*) while other vegetation (stated above), Geographic Information Systems and Remote Sense variable such as elevation, slope and NDVI would be used as site covariates. Ecological Niche Factor Analysis techniques would also be employed using Biomapper 4.0 beta (Hirzel et al. 2002).

Constructing a spatially explicit tiger habitat model

In order to estimate the occupancy of tiger in the landscape, the entire study area would first be gridded into 4km x 4km grids. Following this, grids will be chosen systematically to carry out sampling. Streambeds or *raus*, existing trails and ridge tops will be chosen as the line of walk for tiger sign surveys to maximize probability of encountering tiger signs since tigers are often known to use such paths (O'Brien et al. 2003). Indirect evidences in the form of pugmark, scats and scrapes etc give a good indication of the relative use by tiger of the study area. The beginning and end points of the raus would be marked using a GPS for future monitoring. For the analysis, transect "segments" would comprise the basic sampling unit. Each segment would be of 250m in length. Pugmark encounter rate will be measured as the total number of pugmark encounters upon the total number of segments. The exercise would be carried out with a team of 2-4 persons and on an average take 3-4 hours per transect (1.25-1.5 km/hr). Pugmarks of tigers and other co-predators, whenever encountered would be identified and the continuity of the pugmark sets will be used to identify them as separate encounters. Care will also be taken to avoid double counts of sets. In order to model for occupancy of tiger within the landscape, the selected grids will be used

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to estimate a naive probability of detection. This would then be incorporated into a logistic regression analysis to determine which landscape/ prey attributes best explain the probability of presence of tiger. Following this, the spatially explicit habitat model would be created and repeat surveys for validation carried out.

Estimation of subpopulation size of tigers

In order to estimate the population density of adult tigers in the study area we would use photographic capture-recapture analysis (Karanth 1995, Karanth and Nichols 1998). Forty camera-trapping stations were identified during 2004 in the Chilla range of Rajaji National Park and an additional twenty camera-trapping stations were identified in the ranges of Dholkhand east and Dholkhand west during December 2006 (Harihar et al. in press). These trapping stations were selected so as to maximise the capture probabilities of tigers (Karanth 1995). In addition, we propose sufficiently increase the sampling area based on a reconnaissance survey. In order to systematically sample the area, sampling blocks (spatially separated) will be identified within the intensive study area and the cameras were deployed in a phased manner. Each block would consist of 10 trap sites run for 15 consecutive days/occasions. Thus, each sampling occasion would combine captures from 1 day drawn from each block. One trap-night would be a 14-hour period (1700-0700 hrs) during which a camera would remain functional. Owing to a good network of roads all the 10 trapping sites in a block can checked on a daily basis. Every tiger captured would be given a unique identification number (e.g., RT-002) after examining the stripe pattern on the flanks, limbs and forequarters. Following the identification of tigers, capture histories (X matrix) would be developed and analysed using program CAPTURE (Rexstad and Burnham 1991). The density (D) of tigers in the study area would then be estimated as the population size (N) divided by the effective sampled area ($A(W)$), where $A(W)$ would be estimated by creating a polygon over the trapping stations (A) and a buffer width (W) estimated as half the mean maximum distance moved (½ MMDM) by recaptured tigers added to the camera trap polygon (A).

Modelling the viability of the subpopulations

Using results of the spatially explicit tiger habitat model that is to be developed during this project, viability of these tiger subpopulations to demographic stochasticity will be

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evaluated using unified life models software (Lagendre and Colbert 1995). Viability will be defined as the probability extinction being less than 5% over 50 year's simulation. Life history attributes and stages will follow Karanth and Stith (1999) and Chapron et al. (2008). In order to assess management alternatives, a list of competing models will be developed. These models will incorporate the possible effects of isolation of subpopulations, establishment of connectivity, habitat improvement measures and varying poaching scenarios. Based on these results, appropriate management strategies will be developed to aid manage these subpopulations.

Grant Request

As mentioned above, population of tigers in east RNP is increasing and would need areas to disperse, whereas status of tigers in west RNP is precarious although prey densities are comparable to those in east RNP. West RNP and the adjoining forested areas lying between River Ganges and Yamuna River can potentially support a viable of tigers provided a scientifically designed recovery plan is implemented without much delay. However, to formulate such a plan, managers require timely and reliable information on occurrence, size and viability of existing tiger populations. Therefore, using this grant we shall conduct detailed field surveys to assess the current occurrence patterns of tigers and their prey. Using the field data, we shall construct spatially explicit habitat model for tigers to identify core areas to initiate management interventions. In addition, to facilitate use of appropriate management strategies, viability of each subpopulation would be modelled under various management regimes.

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Table 1. Proposed plan of work from January to December 2009.

	Objective	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Field sampling	Occupancy rates of principal prey species	▨	▨	▨	▨	▨	▨				▨	▨
	Occurrence patterns of tigers	▨	▨	▨	▨	▨	▨				▨	▨
	Density of tigers	▨	▨	▨	▨	▨	▨				▨	▨
	Analysis							▨	▨	▨		
	Report Writing											▨

Grant needed

Therefore, we visualise a need for a grant of Rs. 7, 99,500 (Seven Lakh Ninety nine thousand Rupees) to meet the expenditures during collection of data (January 2009 – December 2009).

S. No.	**Heads**			**Proposed grant**	
		Rate (INR)	**Months**	**Total (INR)**	**Total (CHF)**
1	Fellowship (Senior Research Fellow)	14000	12	168000	4200
2	Field assistants (Two)	5000	12	120000	3000
3	Vehicle Hire	18000	6	108000	2700
4	POL & Maintainence	18000	6	108000	2700
5	Camera Trapping Equipment (40 sets)	5500	NA	220000	5500
6	Miscellaneous	NA	NA	75000	1875
				799000	**19975**

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